Neuse River Basin
North Carolina

Integrated Feasibility Report and Environmental Impact Statement for the Neuse River Basin, North Carolina

PEER REVIEW PLAN

US Army Corps of Engineers
Wilmington District

ACRONYMS & ABBREVIATIONS

AFB – Alternative Formulation Briefing

CESAW – US Army Corps of Engineers, South Atlantic, Wilmington

CWRB – Civil Works Review Board

ECO-PCX - National Ecosystem Planning Center of Expertise

EIS – Environmental Impact Statement

EPR – External Peer Review

FCSA – Feasibility Cost Sharing Agreement

FEIS – Final Environmental Impact Statement

FSM – Feasibility Scoping Meeting

GI – General Investigations

HQ – Headquarters

ITR – Independent Technical Review

LOI – Letter of Intent

NEPA – National Environmental Policy Act

OVEST -- Office of the Chief of Engineers Value Engineering Study Team

PDT – Project Delivery Team

PMP – Project Management Plan

PRP - Peer Review Plan

P&S – Plans & Specifications

SAD – South Atlantic Division

Walla Walla Dx - Walla Walla District Directorate of Expertise for Civil Works Cost Engineering

1.0 The Peer Review Plan

This Peer Review Plan (PRP) is a collaborative product of the project delivery team (PDT) and the National Ecosystem Planning Center of Expertise (ECO-PCX) and the Walla Walla District Directorate of Expertise for Civil Works Cost Engineering (Walla Walla Dx). The ECO-PCX and Walla Walla Dx shall manage the PRP, which for this study includes Independent Technical Review (ITR) only. External ITR is not deemed necessary for the initial review phase. Each of the following paragraphs (a. through j.) correspond to the guidance provided in paragraphs 6.a. through j. of Engineering Circular 1105-2-408, Planning - Peer Review of Decision Documents, 31 MAY 2005.

a. Decision Document and Team Members. The *Integrated Feasibility Report and Environmental Impact Statement for the Neuse River Basin, NC* shall be the decision document. The Neuse River Basin Study is being pursued under the Corps of Engineers' General Investigation (GI) Program. The integrated Feasibility Report and Environmental Impact Statement (EIS) are being conducted in response to a resolution adopted July 23, 1997:

> "Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, That the Secretary of the Army is requested to review the report of the Chief of Engineers on the Neuse River Basin, North Carolina, published as House Document 175, 89th Congress, 1st Session, and other pertinent reports to determine whether modifications of the recommendations contained therein are advisable at the present time in the interest of flood control, environmental protection and restoration, and related purposes."

The Neuse River Basin is the third largest basin in North Carolina, encompassing a total area of 6,235 square miles. The river basin is one of only four basins located entirely within the state and incorporates parts or all of 18 counties. The Neuse River originates in north central North Carolina in Person and Orange Counties and flows southeasterly until it reaches tidal waters near Streets Ferry upstream of New Bern. The river broadens dramatically at New Bern and changes from a free-flowing river to a tidal estuary known as the Neuse River Estuary, which eventually flows into Pamlico Sound. The upper one-third of the basin lies in the Piedmont physiographic province while the lower two-thirds of the basin lie in the Coastal Plain physiographic province.

The Neuse River Feasibility Study is currently investigating stream restoration (reestablishing stream sinuosity, restoring wetlands and riparian buffers, preservation, etc.), anadromous fish habitat restoration (removal of dams and culverts), estuarine restoration (reestablishing oyster reef habitat), and flood damage reduction. The Neuse River, once thriving with abundant species in diverse habitats, has experienced detrimental impacts in water quality. Approximately 555 miles and 3,569 acres within the Neuse River are listed on the 2004 North Carolina 303(d) Impaired Waters List.

Catastrophic flooding occurred during and after Hurricanes Fran in 1996 and Floyd in 1999 in the Neuse River Basin. Within the basin, besides considerable water quality degradation, alteration and destruction of the estuary's habitats, alteration of river flow, and declines in aquatic populations has occurred. The study will address basin-wide improvements to water quality, environmental restoration, flood damage reduction, and related purposes. The State of North Carolina, Division of Water Resources is the non-federal sponsor for this study.

Recommended plans will be formulated to address the needs of the Neuse River Basin at the basin-wide scale. Plan components will be developed by the workgroups to address needs (study objectives) identified above for the individual focus areas. All Alternative Ecosystem Restoration Plans will be subjected to a Modified Habitat Evaluation Procedure. Environmental Quality EQ benefits will be measured in Habit Units (HUs), cost will estimated for each plan and IWR Plan will be used evaluate alternatives for inclusion in the recommended plan. Flood damage reduction benefits will be assessed as National Economic Development (NED) benefits.

Evaluation & Modeling

Freshwater Wetlands, Streams, & Riparian Buffer Restoration

In order to develop preliminary stream restoration alternatives for further evaluation, a screening process was developed to prioritize potential restoration sites as described in Attachment 1. This screening process will be fully coordinated with the internal and external PDT Team members for consensus. The Ecosystem Ranking Criteria and additional screening and prioritization objectives were used to reflect the feasibility of implementing restoration projects in the study area, and were used to rank sites for further field investigation. The Ecosystem Ranking Criteria used in this evaluation process include habitat scarcity, connectivity, special status species, hydrologic character, geomorphic condition, plan recognition, and self-sustaining. Additional criteria used for the ranking of potential restoration sites in the basin include habitat degradation, stakeholder interest, impacts to adjacent projects, areas facing urban and suburban development, land availability, and absence of known Hazardous, Toxic, and Radioactive Wastes (HTRW) issues.

From these criteria, a list of indicators were developed to best measure how a particular project would meet these initial screening criteria and objectives. These indicators were organized into two categories, or tiers: 1) Ecological Integrity (EI) and 2) Others Factors (Attachment 1). The Ecological Integrity tier contains indicators that measure the biodiversity, habitat abundance, presence of rare species, and extent of natural communities in each 14-digit hydrologic unit code in the basin. The Other Factors tier contains indicators that provide information on water quality and hydrology issues, stakeholder interest, and project feasibility. These indicators include North Carolina Ecosystem Enhancement Program (NCEEP) targeted local watersheds, FEMA buyout areas in flood-prone areas that could be used as future sites for restoration, development pressure, areas within water supply watersheds, streams listed on the 2006 integrated 305(b) and 303(d) Report for North Carolina, land availability, Hazardous Substance Disposal sites and landfills, and status of plans for land protection in the Triangle J Council of Governments. The Triangle J Council of Governments is a voluntary organization of municipal and county governments located within the Upper Neuse River Basin. It is one of 18 regional councils established in 1972 by the General Assembly. The linkage between Indicators and Objectives are Presented in Table 1 of Attachment 1.

From the scoring system developed and GIS data, 15 candidate sites are presented in Table 2 of Attachment 1 for further evaluation. The selection process is described in Attachment 1.

Anadromous Fish Habitat Restoration

Water quality degradation, alteration and destruction of the estuary's habitats, alteration of river flow, and commercial and recreational overfishing are factors thought to contribute to declines in anadromous fish population. Construction of dams on some river systems like the Neuse led to a reduction in spawning area for these fish. A reduction in spawning area meant fewer eggs produced and, therefore, fewer fish. Environmental agencies involved in anadromous fish management describe dams as the most detrimental obstruction to migration. Many abandoned millpond dams and small hydroelectric dams remain in piedmont North Carolina and obstruct many hundreds of miles of potential anadromous fish habitat. Several significant reservoirs serving as water supply and flood control structures, along with old millponds and beaver impoundments characterize the Piedmont region of the Upper Neuse River basin. There are 19 major reservoirs in the Neuse River basin, most being in the upper portion of the basin. The largest reservoir, Falls Lake, is managed by USACE for flood control. Reservoirs are few in number in the Coastal Plain physiographic province of the Neuse due to inhibitive factors including highly pervious sands and flat topography.

As a result of greater development pressure and increased population, new highway construction is also impacting more and more streams within the Neuse River Basin. Placement of roadway pipe culverts and reinforced concrete box culverts within stream channels are partially or totally obstructing anadromous fish migration and spawning within the basin. Declines are expected to continue unless causes can be more completely understood and corrective measures taken.

Estuarine Resources Restoration

Oyster restoration plans will be developed based on geospatial analysis of biological and physical data and water quality data from updates of existing models (see Attachment 2). Remote sensing of subtidal oyster reefs in the Neuse River estuary using Side-scan and reconnaissance multibeam survey was completed in July 2006Detailed multibeam survey of identified reef sites has been completed. Updates of the water quality model are ongoing and preliminary model runs and interpretations will be completed. Biological sampling of selected reefs is proposed for 2008.

Initial multibeam data, side scan survey and qualitative biological sampling data was used to located and verify potential reefs in the Neuse River Estuary. These reefs have been characterized and inventoried in a GIS based on site descriptors including their size; complexity (shoreline length to footprint); shape and orientation relative to the thalweg and status as an individual site or part of complex. Additional descriptors including: location within the estuary relative to the upstream limit of the state designated oyster growing area (OGA) and thalweg; volume, height and roughness will be determined and inventoried upon completion of the detailed multibeam survey.

Water quality within the Neuse Estuary is continually monitored as part of extensive ongoing Neuse Estuary monitoring programs at cooperating NC universities and a 3-Dimensional water quality model is available for the Lower Neuse estuary. Combined, these efforts are known as the Neuse River Mod-Mon Project. Water quality and flow data for the Neuse River Estuary OGA (about 185 sq. mi.) will be extrapolated from the aforementioned model for each ~ ¾ sq. mi. grid at 4 water layers including the bottom, surface and two intermediate layers (25% and 75% of depth). Parameters of interest will be collected as available for the period of 1998-2006 including; flow and direction, layer elevation, salinity, dissolved oxygen, temperature and chlorophyll. Grid data for a given water level will be used to interpret normal water quality conditions at various elevations within each grid. The extent of optimal and suitable oyster growing conditions, and the return interval of killing freshets or hypoxia will be determined. Water quality predictions and other physical descriptors as described above will be used to calculate a Habitat Suitability Index (HSI) predicting the potential for establishment of sustainable oyster reefs at a given site.

A sub-sample of reefs that represents the range of site conditions in the Neuse Estuary OGA will be selected for detailed biological sampling and analysis. Replicate biological samples will be collected using hydraulic patent tong to assess oyster condition. The ratio of live oysters to shell, oyster distribution by size class, biomass, disease index and condition will used to assess the status of the existing oyster population. Appropriate statistical analysis will determine the actual correlation of physical parameters with biological attributes. A verified model weighted based on the results of field sampling and analysis, or a statistical model would be developed as appropriate for final selection and evaluation of restoration sites.

Monitoring of subtidal reefs can be difficult since these reefs will occur at water depths over 15 feet. A reconnaissance investigation using hydoacoustic survey of fish populations was conducted to assess the applicability of this method to the Neuse River Estuary. The study report is available describes these efforts and indicates that there is good potential for future application of this method.

Key PDT members are shown in the table below.

ROLE	NAME	ORGANIZATION
Project Manager		SAW-PM-C
Program Manager		SAW-PM-P
Lead Planner		SAW-TS-PF
Biologist, Anadromous Fish & NEPA		SAW-TS-PE
Biologist, Estuarine Resources		SAW-TS-PE
Cultural Resources		SAW-TS-PE
Coastal/H&H		SAW-TS-EC
Coastal/H&H		SAW-TS-EG
Cost Engineering		SAW-TS-EE
Geographic Information Specialist		SAW-TS-EE
Geographic Information Specialist		SAW-TS-EE
Real Estate		SAS-RE-RP
Contract Specialist		SAS-CT-P

For more information regarding the PRP, the project manager for the feasibility study may be contacted as follows:

US Army Corps of Engineers – Wilmington District
CESAW-PM-C
69 Darlington Avenue
Wilmington, North Carolina 28403

Independent Technical Review Team Leaders

b. External Peer Review. EC 1105-2-408 provides the process for deciding whether or not to employ external peer review. The following is an excerpt of EC section 9.a: *Decision documents covered by this Circular will undergo EPR if there is a vertical team consensus (involving district, major subordinate command and Headquarters members) that the covered subject matter (including data, use of models, assumptions, and other scientific and engineering information) is novel, is controversial, is precedent setting, has significant interagency interest, or has significant economic, environmental and social effects to the nation. Decision documents covered by this Circular that do not meet the standard shall undergo ITR as described in paragraph 8, above.*

The vertical team will be included in all levels of review. The USACE, South Atlantic Division has received the Draft feasibility report and has been involved in the Independent Technical Review. This Peer Review Plan has also been submitted to SAD for approval.

For this study, it has been determined that EPR is not required. Please see the External Peer Review Decision Checklist below (1 - 6).

1. Novel subject matter? No.

2. Controversial subject matter? No

3. Precedent setting? No

4. Unusually significant interagency interest? No

5. Unusually significant economic, environmental, and social effects to the nation? No

6. Implementation costs ($50,000,000) trigger EPR? No. Reconnaissance phase costs were $122,000 and total study and project implementation costs are not to exceed the magnitude of $10,000,000 to $25,000,000.

Decision: The PDT suggests that External Peer Review is not required. Independent Technical Review by a US Army Corps of Engineers team external to the project district, CESAW, will be sufficient to comply with the spirit of EC 1105-2-408, Planning - Peer Review of Decision Documents, dated 31 May 2005. It is not anticipated that any new methodologies will be used in the analysis and preparation of the Integrated Feasibility Report/EIS, nor that any of the data collected or analyzed would be considered influential scientific data.

c. Anticipated Peer Review Schedule.

REVIEW PHASE	COMPLETION DATE	
In-House Review	July	2007
Independent Technical Review	**September**	**2007**
Feasibility Scoping Meeting (FSM)	September	2007
In-House Review	Winter	2007
Independent Technical Review	**January**	**2008**
Alternative Formulation Briefing (AFB)	February	2008
Final EIS / NEPA Public Review	Spring	**2008**
Civil Works Review Board	Summer	2008

d. Conducting External Peer Review. The relevant Planning Center(s) of Expertise will make the final determination as to whether or not External Peer Review is to be conducted. For this feasibility study, this decision is the responsibility of the Vertical Team, ECO-PCX, and the Walla Walla Dx. If FDR components are identified the Wilmington District will initiate coordination with the Flood Damage Reduction Planning Center of Expertise and the decision for external peer review would be made at the time.

e. Public Comment on Decision Document. Once completed, the Integrated Feasibility Report and EIS will be disseminated to resource agencies, interest groups, and the public as part of the National Environmental Policy Act (NEPA) environmental compliance review. Please note where "FEIS / NEPA Public Review" is highlighted in the "Peer Review Plan" flow chart included as Attachment 3. Public entities and private individuals may also review and comment on draft documents as members of the PDT.

f. Provision of Public Comments to Reviewers. All significant and relevant public comments will be provided as part of the review package to Peer Reviewers as they are available and may include but not be limited to: scoping letters, meeting minutes, other received letters, and emails.

g. Anticipated Number of Reviewers.** The relevant Planning Center(s) of Expertise shall make the final determination for the number needed of reviewers. For this feasibility study, this decision is the responsibility of the ECO-PCX and the Walla Walla Dx.

h. Primary Review Disciplines and Expertise. The number of reviewers (Level of Review) shall vary as depicted under "Review Phase" in the "Peer Review Plan" flow chart included as Attachment 3. The ECO-PCX and the Walla Walla Dx shall make the final determination for the discipline type and number needed of reviewers depending upon the "Review Phase."

PRELIMINARY REVIEW DISCIPLINES FOR ITR**
Plan Formulation
Environmental / NEPA Compliance
Hydrology & Hydraulics
Cost Estimating

As the Neuse River Feasibility Study proceeds, additional reviewing disciplines will be added.

i. Selection of External Peer Reviewers. The relevant Planning Center(s) of Expertise and associated Vertical Team shall make the final determination for the discipline type and number needed of reviewers as well as which if any External Peer

Reviewers are needed. For this feasibility study, this decision is the responsibility of the ECO-PCX and the Walla Walla Dx.

j. Nomination of Peer Reviewers by the Public. The ECO-PCX and the Walla Walla Dx shall determine if Peer Reviewers will be nominated by the Public. The public will have opportunities to review the Integrated Feasibility Report/EIS as required by the NEPA compliance process.

k. Format for Compiling Peer Review Comments. The ITR team will document its comments and recommendations, for all formal reviews, utilizing the DrChecks module in ProjNet in accordance with ER 1110-1-8159. Comments will be structured to give a clear statement of the concern, the basis of the concern and, when appropriate, the actions necessary to resolve the concern. Comments will cite appropriate references. The PDT will evaluate and respond to each comment in DrCheckssm. Responses will clearly state concurrence or non-concurrence with the comment. Concurrences shall include what the corrective action is and where and when it will be done. Non-concurrences shall include an explanation or proposed alternative action. All comments are to be resolved and back checked in the DrCheckssm project record prior to ITR certification.

i. Models and Certification. A planning level model is being used for screening streams for restoration. Multiple models are being used for evaluation of estuarine resource restoration. For model certification purposes, please see Attachments 1 and 2 for further descriptions of the models including how they are being used, what data is input into the models, and who developed the models.

** See Attachment 4

ATTACHMENT 1

WETLAND, STREAM, AND RIPARIAN BUFFER RESTORATION ALTERNATIVES SCREENING AND EVALUATION: INITIAL PRIORITIZATION OF STREAMS IN THE NEUSE RIVER BASIN

Wetland, Stream, and Riparian Buffer Restoration Alternatives Screening and Evaluation:

Initial Prioritization of Streams in the Neuse River Basin

Prepared for:

U.S. Army Corps of Engineers,

Wilmington District

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July 2007 Draft

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Introduction

The U.S. Army Corps of Engineers (USACE), Wilmington District has initiated a feasibility study to recommend appropriate federal basin-wide solutions to aquatic ecosystem degradation in the Neuse River Basin. The North Carolina Department of Environment and Natural Resources (NC DENR) (led by the NC Division of Water Resources (NC DWR)) is partnering with USACE, Wilmington District on this effort. Tetra Tech has been contracted to screen and prioritize stream, wetland, and riparian buffer restoration opportunities within the Neuse River Basin.

The feasibility study will identify restoration projects that will mitigate for degraded ecological functions within the basin. Many streams within the Neuse River Basin have experienced degradation due to the impacts of agriculture, urbanization, and other stressors. As indicated by a few remaining high-quality natural areas, both the Piedmont and Coastal Plain watersheds of the Neuse River basin once supported diverse communities of aquatic and terrestrial wildlife. During European settlement, much of the native terrestrial and wetland habitat was destroyed, forests were cleared for timber and agriculture, and wetlands were frequently drained and converted for agricultural use.

More recently, the impacts associated with urban and suburban development have contributed to ecological degradation, with rapid development occurring in the upper areas of the Neuse Basin. This development has increased nutrient and sediment loads to the streams. Urbanization has altered stream hydrology and is a major cause of stream degradation. The Neuse River and many of its tributaries have been impounded for a variety of uses including agricultural irrigation, water supply, and hydropower; these impoundments have significantly altered the natural hydrology of the basin.

A combination of agricultural and urban sources has been identified as the cause of high nutrient concentrations in the Neuse Estuary and the resulting degradation of aquatic communities. Urbanization impacts are concentrated in the upper half of the basin, while the agricultural impacts are more prevalent in the lower half of the basin. The abundance of waste lagoons associated with hog farms in the Coastal Plain is a major source of the excessive nutrient loads delivered to the Neuse River.

Flooding is a concern throughout the basin due, in part, to increased runoff volumes and elevated peak rates of runoff from urban areas. Development in the floodplain has also been a cause of flood damage during hurricanes; this hazard has been partially mitigated through the FEMA buyout program and floodplain regulations. Small impoundments exist throughout the basin, and it is likely that older dams exist that have not been properly designed to handle major or catastrophic storm events.

Through the feasibility study, USACE Wilmington District seeks restoration projects that address the many impacts to ecosystems in the Neuse River Basin. Environmental restoration opportunities are being addressed in plans to be developed by three Workgroups: 1) Stream, Wetland, and Riparian Buffer Restoration; 2) Oyster Habitat Restoration; and 3) Anadromous Fish Restoration. This document summarizes the initial prioritization for the first Workgroup Plan: Stream, Wetland, and Riparian Buffer Restoration. The initial prioritization involved developing a list of 8 to 10 recommended restoration opportunities. During the next stage of the project, field investigation and further evaluation will be conducted to prioritize the top three restoration projects.

Screening and Initial Prioritization Objectives

The overall goal of the feasibility study is to identify impaired ecosystems and restore them to a more natural condition. To achieve this goal, the USACE plans to meet a number of objectives. These objectives relate to 1) the ecological conditions of the ecosystems, as well as 2) the feasibility of implementing restoration projects. The specific screening and prioritization objectives are drawn from a broader set of national, regional, and local priorities.

Screening objectives were first derived from the USACE Ecosystem Ranking Criteria that are used to compare environmental restoration projects across the nation. The criteria also aid USACE in selecting the projects that will provide the most cost-effective means of restoring ecosystem functions. The following list presents the USACE Ecosystem Ranking Criteria (in bold) and the resulting objective.

- **Habitat Scarcity:** Restore scarce habitat.
- **Connectivity:** Facilitate movement of species; restore streams with connectivity to existing, high quality natural areas; or increase biodiversity within an ecosystem.
- **Special Status Species:** Provide key life requisites for threatened or endangered species.
- **Hydrologic Character:** Restore and sustain the natural hydrology of the ecosystem.
- **Geomorphic Condition:** Restore the natural geomorphic structure and processes to the site.
- **Plan Recognition:** Support goals of existing watershed or basin plans.
- **Self-Sustaining:** Minimize the amount of maintenance required to sustain the project.

In addition to these objectives, Tetra Tech incorporated criteria specifically outlined by the USACE, Wilmington District for the Neuse River Basin. The resulting objectives were:

- **Habitat Degradation:** Identify streams where good or fair conditions exist and where restoration of degraded aquatic habitat will likely be successful and not cost-prohibitive.
- **Interested Stakeholders:** Identify projects with supportive stakeholders.
- **Adjacent Projects:** Identify projects that will contribute to the benefits of existing, adjacent projects.
- **Facing Urban/Suburban Development:** Identify projects that are facing development pressure from urban or suburban development.
- **Land Availability:** Identify projects on land owned by public entities or conservation organizations.
- **Absence of Known HTRW Issues:** Avoid projects with Hazardous, Toxic, or Radioactive Waste (HTRW) issues.

Tetra Tech used the above objectives to establish methods for screening restoration opportunities based on the likelihood that each project would meet the objectives. The following section describes how these methods were developed.

Scoring Methodology

Once the prioritization objectives were finalized, Tetra Tech obtained readily available GIS data and developed a list of indicators that were directly linked to the objectives. Tetra Tech divided the basin into watersheds using 14-digit Hydrologic Unit Codes (HUCs) and used the indicators to score the watersheds according to ecological conditions, project feasibility, and other factors. This section describes in more detail how Tetra Tech developed the scoring methodology.

Data Collection

As directed by the USACE, Wilmington District, Tetra Tech compiled readily available GIS data that could be used to develop indicators for evaluating proposed projects. Most GIS data were obtained through the NC OneMap website (www.nconemap.com), a program that provides a comprehensive set of geospatial data covering the entire state of North Carolina. Several other sources were used to obtain information not available from NC OneMap. Data on natural vegetation coverage were obtained from the North Carolina Gap Analysis Program (www.basic.ncsu.edu/ncgap/Index.html). The location and extent of existing and planned protected areas in the Upper Neuse River Basin were obtained from the Triangle GreenPrint project website (www.trianglegreenprint.org). USACE, Wilmington District, with permission from the North Carolina Natural Heritage Program (NHP), gave Tetra Tech access to detailed data on the location of threatened and endangered species, significant natural areas, and other natural heritage priorities. The USACE, Wilmington District also provided the locations of Natural Resource Conservation Service (NRCS) conservation easements as well as flood buyout, or hazard mitigation, properties within the Neuse River Basin.

Development of Spatial Screening Units

The scoring approach required an appropriately sized spatial unit to score and compare restoration opportunities across the basin. A site-level analysis did not fit within the scope of work because many potential restoration project locations had not been explicitly identified. A watershed-scale analysis was appropriate to more generally quantify conditions throughout the Neuse River Basin. This approach also allowed for identification of additional watersheds that are both appropriate for restoration and are expected to support restoration projects. The methods were developed so that once the location of potential restoration projects within a watershed was determined, the project would receive scores based on the conditions within the watershed.

As an appropriate watershed delineation, Tetra Tech selected the 14-digit Hydrologic Unit Codes (HUCs) developed by the Natural Resources Conservation Service (NRCS) in cooperation with NC DWQ and NC Center for Geographic Information & Analysis (NC CGIA) (NC CGIA, 1998; NRCS, 1995). The Neuse River Basin contains 200 14-digit HUCs that range in area from 3 to 273 square miles, with an average of 31 square miles. Tetra Tech determined that the next largest unit, the 11-digit HUC, was too large and would not produce enough variation in the basin to effectively prioritize projects.

Selection of Indicators

From the available GIS data, Tetra Tech selected indicators that would best measure how a particular project would meet the USACE objectives. The indicators were organized into two categories, or tiers:

1) Ecological Integrity and 2) Other Factors. The Ecological Integrity tier contains indicators that measure the biodiversity, habitat abundance, presence of rare species, and the extent of natural communities in each 14-digit HUC. As a whole, this tier was developed to identify which projects were likely to restore and maintain sustainable ecosystems. The Other Factors tier contains indicators that provide information on water quality and hydrology issues, stakeholder interest, and project feasibility. The following list briefly describes each indicator.

- **Ecological Integrity**
    - **IBI Score:** Index of Biological Integrity (IBI) ratings for fish community sites sampled by NC Division of Water Quality (DWQ).
    - **Bioclass:** Water quality classification based on DWQ biological monitoring of benthic macroinvertebrates.
    - **Anadromous Fish:** NC Division of Marine Fisheries designated locations of sites where fish swim upstream to spawn (Anadromous Fish Spawning Areas).
    - **Aquatic NHEO:** Locations of rare and endangered species, wildlife habitats, and ecosystems (Natural Heritage Element Occurrences) maintained by the NC Natural Heritage Program (NHP).
    - **NCGAP Wetlands:** Location and extent of wetland vegetation classified by the NC Gap Analysis Program.
    - **Significant Natural Heritage Areas:** Areas where ecologically significant natural communities or rare species have been identified by NHP.
    - **NCGAP Priority Terrestrial Habitat:** Location and extent of terrestrial habitat prioritized by the NC Wildlife Resources Commission for NC Ecosystem Enhancement Program (EEP) Local Watershed Plans (LWPs) within or near the Neuse River Basin. The vegetation data were classified by the NC Gap Analysis Program. Natural grassland was excluded from the priorities because NCGAP does not distinguish between natural grassland and pasture.
- **Other Factors**
    - **NCEEP Targeted Local Watersheds:** Watersheds were prioritized by NCEEP for restoration and protection based on the following factors: water quality problems, cumulative wetland and stream impacts, resource values, existing watershed initiatives, partnership opportunities, land cover, and input from local resource professionals.
    - **Flood Buyout:** Properties purchased by Federal Emergency Management Association (FEMA) in an effort to remove buildings from flood-prone areas and mitigate flood hazards.
    - **Development Pressure:** Land near urban areas or municipal boundaries.
    - **Water Supply Watershed:** Extent and protection status of land within water supply watersheds.
    - **303d/305b:** Streams listed on the 2006 Integrated 305(b) and 303(d) Report for North Carolina (NC DWQ, 2007).

- **Land Availability:** Land under public ownership and/or conservation land (both public and private).
- **HTRW:** Presence of Hazardous Substance Disposal Sites (HSDS) and Landfills.
- **Triangle GreenPrint:** Status of plans for land protection in the Triangle J Council of Governments.

The indicators above are directly linked to USACE objectives as shown in Table 1. Multiple indicators were selected to address each objective; although this can lead to double-counting, it was important to use multiple indicators because some indicator data were not available for all 14-digit HUCs. Also, each indicator differs in the type and subject of its measurement to help ensure that high-quality areas are not overlooked. For example, all five ecological integrity indicators are linked to the Habitat Scarcity objective; however, each indicator provides information on a different type of habitat: Bioclass for macroinvertebrate habitat, Aquatic NHEO for aquatic habitat in general, NCGAP Wetlands for wetland habitat, etc. The relationship between the indicators and USACE objectives was considered throughout the methods development and prioritization. The following section describes the methods used to score candidate projects based on the indicators.

Table 1. Linkage between Indicators and Objectives

Tier	Indicator	USACE Ecosystem Ranking Objectives	Wilmington District Objectives
Ecological Integrity	IBI Score	Habitat Scarcity, Hydrologic Character, Geomorphic Condition	Habitat Degradation
	Bioclass	Habitat Scarcity, Hydrologic Character, Geomorphic Condition	Habitat Degradation
	Anadromous Fish	Habitat Scarcity	NA
	Aquatic NHEO	Habitat Scarcity, Special Status Species	Habitat Degradation
	NCGAP Wetlands	Habitat Scarcity, Connectivity, Self-Sustaining	NA
	Significant Natural Heritage Areas	Habitat Scarcity, Special Status Species, Connectivity	NA
	NCGAP Priority Terrestrial Habitat	Habitat Scarcity, Connectivity	NA
Other Factors	NCEEP Targeted Local Watersheds	Plan Recognition, Self-Sustaining	Interested Stakeholders, Adjacent Projects
	Protected Land	Connectivity, Self-Sustaining	Adjacent Projects
	Flood Buyout	Hydrologic Character, Plan Recognition	Interested Stakeholders, Adjacent Projects
	Development Pressure	Self-Sustaining	Facing Urban/Suburban Development
	Water Supply Watershed	Connectivity, Self-Sustaining, Plan Recognition	Interested Stakeholders
	303d/305b	Hydrologic Character, Geomorphic Condition, Self-Sustaining, Plan Recognition	Interested Stakeholders
	Land Availability	Connectivity, Self-Sustaining, Plan Recognition	Interested Stakeholders, Land Availability, Adjacent Projects
	HTRW	Self-Sustaining	Absence of Known HTRW Issues
	Triangle GreenPrint	Connectivity, Self-Sustaining, Plan Recognition	Interested Stakeholders, Land Availability, Adjacent Projects

Development of Scoring System

Once the indicators were selected, Tetra Tech developed methods to translate the indicator data into scores. The scoring system provides a consistent means of comparing conditions and constraints across the suite of indicators. The scores were used to identify 14-digit HUCs and projects within those watersheds that best meet the feasibility study objectives.

An intermediate step in this process was to establish metrics, or discrete methods of assessing variability in the data. For each indicator, Tetra Tech determined appropriate metrics and methods for translating the metrics into scores. Appendix A presents the metrics and score translation for each indicator. GIS analysis was used to compile a dataset of metrics that are presented in **Error! Reference source not found.**. Then, the scoring system was used to translate the metrics into scores for each 14-digit HUC (**Error! Reference source not found.**).

To facilitate the prioritization, an Ecological Integrity (EI) composite score was developed for each
14-digit HUC using the EI tier indicators. The composite score was calculated by summing the scores for each 14-digit HUC and dividing by the number of indicators. If a 14-digit HUC did not have data for a particular indicator, then the sum of scores was divided by only the number of indicators with available data, preventing a HUC from receiving a lower score for missing data. Missing data are indicated with a blank cell in the data tables.

The indicators in the Other Factors tier deal with a number of different issues, and a composite score for this tier would be difficult to interpret in relation to the objectives. Instead of calculating an Other Factors composite score, Tetra Tech determined that it would be more appropriate to evaluate the Other Factors scores individually as part of the screening process.

The locations of the preliminary candidate projects within 14-digit HUCs were determined so that each potential project could be scored. To determine the approximate location of the projects, Tetra Tech used location information and contacts provided by USACE, Wilmington District. Some project locations had already been identified at the site level while other projects were proposed for one or multiple 14-digit HUCs, with the site location to be determined. Projects spanning multiple HUCs received multiple scores – one score for each 14-digit HUC – which allowed Tetra Tech and USACE to evaluate which 14-digit HUCs would be most appropriate for further reconnaissance. A map of the site locations and corresponding EI composite scores is provided in **Error! Reference source not found.**.

As directed by USACE, Tetra Tech identified additional projects from a review of the NCEEP Local Watershed Plans in the Neuse River Basin (NCEEP, 2007), the DWQ 2002 Neuse River Basinwide Water Quality Plan (NC DWQ, 2002), and Tetra Tech's past experiences. These projects were added to the proposed projects list and scored using the above methods. The complete project list, including scores, is provided in **Error! Reference source not found.**.

Project Prioritization

Tetra Tech used the scoring system and available GIS data to develop a list of 10 candidate projects recommended to the USACE, Wilmington District for further evaluation. Tetra Tech used a step-wise process to document how the projects were selected. The steps involved using the scores to select priorities and evaluating the priorities in more detail using the GIS data directly. The following steps were used in the selection process:

1. Prioritize projects with "Fair" to "Good" ecological functionality using EI composite scores of
   2 to 4 (assuming EI score of 5 = Excellent, 4 = Good, 3 = Good-Fair, 2 = Fair, and 1 = Poor). Scores above 4 would tend to indicate highest quality areas more applicable to preservation than restoration, and scores below 2 were thought to represent more severely degraded areas that may not be able to achieve the restoration objectives set forth.
2. Overlay project location with GIS data and evaluate relationship between the project and the EI indicators. Prioritize projects where the EI score reasonably reflects conditions on or near the project site.
3. Evaluate the Other Factors tier for priority projects. Prioritize projects that have high scores for these indicators.
4. Evaluate how the proximity of available land, HTRW issues, and impaired streams will affect project feasibility. Prioritize projects that do not present problems in or upstream of the project area that could prevent objectives from being achieved.
5. Evaluate how the list of prioritized projects will benefit the basin as a whole, and prioritize projects that will have the greatest impact on functional uplift.
6. Identify promising projects that will require further investigation, including non-restoration projects and projects that did not have specific site locations.
7. Present recommendations to USACE and revise list based on USACE input.

Using these steps, Tetra Tech developed a list of priority projects, as shown in Table 2. Tetra Tech initially recommended 10 projects, as indicated by "Tt" in Table 2. Tetra Tech also noted four projects ("Tt*") that did not have project sites specified and would require further investigation. Tetra Tech presented these priorities to USACE, Wilmington District during the May 30, 2007 Prioritization of Streams meeting.

During the May 30 meeting, Tetra Tech and USACE discussed the feasibility of six other projects. USACE recommended adding Project #9 Adkin Branch to the priorities; this project – although running through an urban area with multiple landowners – generally had favorable scores, and the City of Kinston and other entities were interested in partnering on the project. Tetra Tech had originally set aside projects #101-104 and #114 from the priorities since the benefits of these projects would likely be limited to the area upstream of Falls Lake. Tetra Tech discussed this issue with USACE, and USACE determined that, due to their high scores and potential benefits, these projects should be included on the prioritized list. These projects are designated "USACE" in Table 2.

Table 2. Preliminary Project Recommendations by Tetra Tech and USACE, Wilmington District

ID	Code[1]	DESCRIPTION	TYPE
9	USACE	Adkin (Yadkin) Branch	Restoration
10	Tt	Sand Mine	Wetland Creation
12	Tt*	Little River and Buffalo Creek Watershed	BMP/Restoration
17	Tt	Contentnea Ck nr Stantonsburg	Bank Stabilization
19	Tt	Swift Ck at NC-118	BMP/Restoration
20	Tt	Swift Ck near Askin	BMP/Restoration
21	Tt	Clayroot Swamp	BMP/Restoration
23	Tt*	Broad and Swan Creeks, Neuse Subestuary	Ditch BMPs/Stream/Marsh Restoration
29	Tt*	Bay River: Neuse Subestuary, etc.	Ditch BMPs/Stream/Marsh Restoration
30	Tt*	Jones and Middle Bays: Neuse Subestuary, etc.	Ditch BMPs/Stream/Marsh Restoration
101	USACE	Lick Creek	Restoration-Instream
102	USACE	Little Lick Creek	Restoration
103	USACE	New Light Creek	Restoration
104	USACE	North Fork Little River	Restoration
109	Tt	Swift Creek	Restoration
111	Tt	Little Contentnea Creek	Restoration-Instream
114	USACE	Ledge Creek	Small Scale Restoration
120	Tt	Yates Mill Run Borrow Pit	Wetland Creation

[1] Tt – projects originally recommended by Tetra Tech; Tt* – Projects without site locations that are recommended for further evaluation; USACE – Projects added to priority list after discussion with USACE.

Tetra Tech identified two opportunities with high preservation potential that are not shown in Table 2:
#8 Mill Creek and #110 Neuse Bottomlands. USACE will consider the feasibility of preservation efforts within these watersheds separately from the restoration opportunities. Tetra Tech also recommended two restoration opportunities that overlap with the efforts of the Anadromous Fish Restoration Workgroup: #1 Upstream of Milburnie Dam and #7 Middle Creek. To reduce the potential for duplicate efforts between the two groups, these dam removal opportunities were removed from further consideration within the efforts of the Stream, Wetland, and Riparian Buffer Restoration Workgroup.

References

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NC DWQ. 2007. Final North Carolina Water Quality Assessment and Impaired Waters List (2006 Integrated 305(b) and 303(d) Report). NC Department of Environment and Natural Resources, Division of Water Quality. <http://h2o.enr.state.nc.us/tmdl/General_303d.htm#Downloads> Accessed July 2007.

NRCS. 1995. North Carolina Hydrologic Unit River Basin Study. USDA Natural Resources Conservation Service, Raleigh, NC.

Appendix A. Scoring System

Table A-1. Scoring System for Ecological Integrity Tier

Fish Community		
Average of IBI Ratings in HUC[1]	**Code**	**Score**
Excellent	5	5
Good	4	4
Good/Fair	3	3
Fair	2	2
Poor	1	1
Not Evaluated	No Data	
No Data	No Data	
[1]The most recent observation was used for multiple observations at a single site.		
Benthic		
Average of Bioclass in HUC[2]	**Code**	**Score**
Excellent	5	5
Good	4	4
Good/Fair	3	3
Fair/Not Impaired	2	2
Poor	1	1
Not Evaluated	No Data	
No Data	No Data	
[2]The most recent observation was used for multiple observations at a single site.		
Anadromous Fish		
Anadromous Fish Spawning Areas	**Code**	**Score**
Intersects with spawning area	Yes	5
Does not intersect	No	1

Aquatic NHEO

Natural Heritage Element Occurrences - Aquatic Species[3]	Code	Score
At least 10 Existing Aquatic NHEOs	10 or More Existing	5
Contains under 10 Existing Aquatic NHEOs, but more existing than historic	Majority Existing	4
Contains more historic than existing aquatic NHEOs (max historic is 7 per HUC, basinwide)	Majority Extirpated	3
Contains wetland NHEOs but does not contain aquatic NHEOs	Wetland, No Aquatic	2
Contains upland NHEOs but does not contain aquatic or wetland NHEOs	Upland, No Aquatic or Wetland	1
Contains no NHEOs (assumed not surveyed)	No Data	

[3]Based on "Type" field in Natural Heritage GIS data

NCGAP Wetlands

Proportion of Wetland Species Alliance[4] in HUC	Upper Limit	Score
Top 20%	69%	5
Mid-Upper 20%	26%	4
Middle 20%	14%	3
Mid-Lower 20%	9%	2
Lowest 20%	5%	1

[4] Includes all wetland species alliances, including maritime wetlands and wetlands designated as NCWRC priorities for NCEEP preservation.

Significant Natural Heritage Areas

Significance Level	Code	Score
Contains at least one SNHA of National Significance	National	5
Contains at least one SNHA of State Significance (no National)	State	4
Contains at least one SNHA of Regional Significance (no National or State)	Regional	3
Contains at least one SNHA of Local Significance (no National, State, or Regional)	Local	2
Does not contain an SNHA but has been considered/surveyed by NH program (NHEOs present)	No SNHA	1
Not surveyed	No Data	

NCGAP Priority Terrestrial **NCGAP Priority Terrestrial Species Alliances**		
Proportion of Priority Land Cover[5] in HUC	**Upper Limit**	**Score**
Top 20%	36%	5
Mid-Upper 20%	25%	4
Middle 20%	20%	3
Mid-Lower 20%	14%	2
Lowest 20%	10%	1
No priority land cover in HUC	0%	0

[5]Based on NCWRC priority habitats identified for NCEEP projects.

Table A-2. Scoring System for Other Factors Tier

NCEEP Targeted Watersheds and Plans		
HUC Designation and Status	**Code**	**Score**
HUC is designated as a targeted local watershed and has a completed local watershed plan (LWP).	Plan Completed	5
HUC is designated as a targeted local watershed, but the LWP has not been completed.	Targeted	3
Otherwise	Not Targeted	1
Flood Buyout		
Presence of Hazard Mitigation (Flood Buyout) Property	**Code**	**Score**
HUC contains more than 5 acres of flood buyout properties	5	5
HUC contains <5 acres of flood buyout properties	<5	3
HUC contains 0 acres of flood buyout properties	0	1
Development Pressure		
Percent of Land within 1 Mile of Urban Areas or Municipal Boundaries	**Upper Limit**	**Score**
Top 20%	73%	5
Mid-Upper 20%	42%	4
Middle 20%	28%	3
Mid-Lower 20%	17%	2
Lowest 20%	9%	1
No land within 1 mile of urban areas or municipal boundaries	0%	0

Water Supply Watershed

Watershed Classes	Code	Score
WS I	I	5
WS II	II	4
WS III	III	3
WS IV	IV	2
Does not intersect with a Water Supply Watershed	No WSW	1

303d/305b

Listing According to Draft 2007 303d/305b List	Code	Score
An impaired waterbody exists within a HUC	Yes	1
Waterbodies within HUC were sampled for benthic/fish community/WQ, but none are 303d/305b listed.	No	3
Not sampled for benthic/fish community/water quality	No Data	

Land Availability

Land Availability (List info sources[6])	Code	Score
HUC contains known public and/or conservation land (both public and private)	Yes	5
No data available on land availability	No Data	

[6] Sources included: Conservation Tax Credit Properties, State Lands, Federal Lands, Game Lands, Lands Managed for Conservation and Open Space, Land Trust Properties, NRCS Conservation Easements, and Existing Triangle GreenPrint Land.

HTRW

Presence of Hazardous Substance Disposal Sites (HSDS) and Landfills	Code	Score
HUC contains HSDS site or Landfill	Yes	1
No data on HTRW issues	No Data	

Triangle GreenPrint

Triangle GreenPrint - Status of Plans for Land Protection in the Triangle J Council of Governments[7]	Code	Score
HUC includes at least one Planned GreenPrint property that is entirely public	Planned, Public	5
HUC includes at least one Planned GreenPrint property that includes at least some private land	Planned, Private	4
HUC includes at least one Proposed GreenPrint property, but no Existing or Planned	Proposed	3
HUC includes at least one Desired GreenPrint property, but no Existing, Planned, or Proposed	Desired	2
Intersects with TJCOG counties, but does not include designated GreenPrint property	No GreenPrint Sites	1
Not in Durham, Orange, Wake, or Johnston (TJCOG Counties)	No Data	

[7] Tetra Tech removed SNHAs to avoid double counting.

ATTACHMENT 2

ESTUARINE RESOURCES RESTORATION MODELING

Modification of Hydrodynamic and Water Quality Models for the Neuse River Estuary in North Carolina

This model would be capable of identifying areas within the Neuse Estuary that are expected to provide suitable water quality to support persistent oyster habitat under existing and projected future conditions. This tool would also be used to predict the viability of existing reefs, and evaluate reef restoration alternatives for degraded sites. The objective of this effort is the use of existing Neuse Estuary water quality models to predict suitable and unsuitable locations within the estuary for oyster reef restoration. USACE is using the existing Neuse River Estuary EFDC and WASP water quality models. Descriptions of EFDC and WASP are in the next section. A post processor is to be developed that will analyze the model results. The post processor will evaluate hydrodynamic and water quality parameters suitable to support persistent oyster reef habitats. Models and post processor will be used to identify locations and depths within the Neuse estuary that are (1) not expected to support persistent oysters, (2) have moderate potential to support persistent oysters and (3) have a high probability to supporting persistent oyster reef habitat.

Three computer simulation models of the Neuse system were developed to determine nutrients loads and their impact on the Estuary. The model HSPF was developed to simulate the watershed flows and to determine the amount of nutrients entering the Neuse River from point and non-point sources. The second model developed was the 3-dimensional hydrodynamic model EFDC and was used to simulate the complex circulation patterns of the estuary. Circulation in the estuary is driven by a combination of Neuse River flows, tides, salinity density and wind driven sieches. The water quality model WASP was used to simulate nutrient transport and cycling in the estuary. WASP uses nutrient loads entering the estuary from the LSPC watershed model and the circulation results from EFDC to define transport of the nutrients. From the models it is possible to estimate levels of chlorophyll-a and dissolved oxygen within the Neuse Estuary and determine the impact nutrients have on those levels.

Conduct a data collection effort of readily available hydrodynamic and water quality data required to accomplish the statement of work. Data sources include but may not be limited to the USGS, USEPA, NOAA, NC Division of Water Quality, University programs and the ModMon program. Review the sufficiency of the information collected to identify any known gaps in pertinent information and expected limitations on the intended use of the model shall be identified. USACE will use the existing EFDC and WASP models of the Neuse Estuary as developed by the EPA with no modifications to the spatial coverage of the grid. That is, no change to the horizontal and vertical resolution of the current grid. The time series files will be extendedwith the latest dataset readily available. EFDC and WASP modeling will be used to address and accomplish the following work:

1. Convert the models to the most current versions of EFDC and WASP.
2. The existing models have a simulation period that ends on December 31, 2000. The model simulation period shall be extended by updating the boundary conditions to as late a date as possible, based on the availability of the data. Hydrologic, meteorological and water quality data used in expanding the models shall be collected from readily available sources.
3. Confirm that any modifications to the models have not violated earlier calibrations. The model shall be verified to the same 1998 to 2000 hydrodynamic

and water quality data set used in the EPA TMDL model. The modified model shall also be compared to new data, in a validation period,

4. Graphs comparing model results to field data shall be prepared.

USACE will execute model simulations.

1. Water Quality Runs for Oyster Reef Habitat Suitability – EFDC and WASP models will be run for the extended simulation period for all available water quality parameters. The models runs shall include:
    a. Existing nutrient loading and boundary conditions over the extended simulation period.
    b. Six model runs with changes in the 1999 nutrient levels entering the Estuary from the Neuse River with history boundary conditions; reductions of 10%, 30%, and 50%; increase of 10%, 30%, and 50% to the Total Nitrogen concentrations (or loads).
    c. Evaluate reductions in nutrient (chlorophyll-a) levels in the estuary by restored oyster reefs. Surface areas restored will be provided by the District.
2. Larvae Transport - The dispersal of oyster larvae on and off the reefs are of interest. Characteristic of the oyster larvae will be provided by the Wilmington District. The direction, distance and travel times for larvae suspended within the water column will be determined by the hydrodynamic models over the extended simulation period. Statistical analysis will be preformed with post processors.

Post processors shall be developed to interpret the EFDC and WASP model output and to evaluate water quality and flow as components of oyster habitat suitability. The post processors shall be designed in a modular approach for ease of use by Wilmington District personnel. The details of the post processors are defined below.

For each grid cell and each of 4 layers. Period of analysis: (1) period of record and (2) last 24 months. Evaluate both annual and summer condition. Output Format will be GIS Layers and Excel Spreadsheets. The specific requirements of the post-processor include the following:

- Elevation:
    - Average
    - Average by Month
- Salinity:
    - Average
    - Range
    - Standard Deviation
    - Average by Month
    - % of analysis period within optimum range of salinity values of growing conditions defined as 14-28ppt: Total, High, and Low
    - % Salinity > 5ppt
    - % salinities below predator preference target < 15ppt
    - Mean interval between killing freshet: <2 ppt for >30 days or < 1 for 5 days
    - Dates (total extent) and average temperature for each event
- Dissolved Oxygen
    - Average
    - Range
    - Standard Deviation

    - Average by month
    - % > 3
    - Mean interval between killing hypoxia: < 1, 0 for > 3 days, or > 2 for >5 days.
    - Dates (total extent) and average temperature for each event
- Temperature
    - Average
    - Range
    - Standard Deviation
    - Average by Month
    - % > Disease Target > 20 C
- Current velocity and direction (dominant)
    - Average
    - Range
    - Standard Deviation
    - Monthly Average
- Chlorophyll
    - Average
    - Range
    - Standard Deviation
    - Average by Month

The post processor will also include the following:

1. BMD Diagnosis – The program will read EFDC and WASP output files (*.bmd) and extract user defined parameters and save as ASCII text files.
2. Percentile Distributions – The program will read EFDC and WASP output and calculate the parameter percentile exceedance (both high and low as appropriate) at each grid cell for each defined layer. The percentile exceedance, parameters and time period should be user defined. Parameters of primary interest include; salinity, dissolved oxygen, water temperature, velocity and chlorophyll-a. Time periods of interest include: period of record, annual, seasonal and weekly events that bracket periods of ecological significance to oysters (e.g. low DO periods, freshets, prolonged high salinity, oyster spawning season, etc.). Analysis of frequency of recurring lethal events such as killing hypoxia/anoxia or freshets for various periods is also of interest.

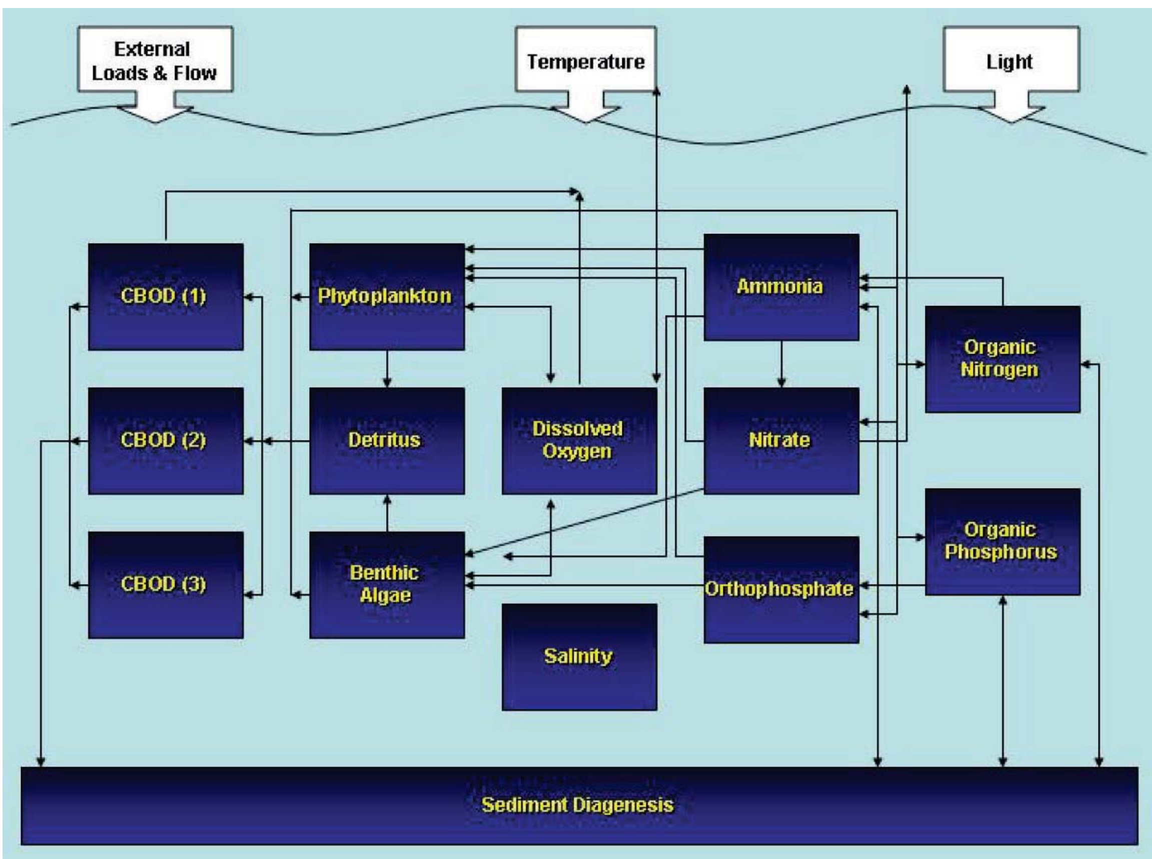
USACE will code the theoretical weighted model describing the combination of water quality, flow and larvae transport criteria that represent conditions suitable to classify grids as (1) not expected to support persistent oysters, (2) having moderate potential to support persistent oysters and (3) having a high probability to support persistent oyster reef habitat. This model will compute a Habitat Suitability Index (HSI) where ideal habitat would have a value of 1 and non-supporting habitat would be 0. An appropriate range of HSIs will be determined to describe each classification and used to identify potential oyster restoration areas within the Neuse Estuary. Any factors that detract from a given grid cells' HSI should be identified.

Minimum criteria to be used in the evaluation will be dissolved oxygen, salinity, temperature, chlorophyll-a, flow velocity and potential to receive larvae, unless analysis or evaluation demonstrates these parameters to be inappropriate. Additional parameters may be added as demonstrated to be pertinent. The habitat trigger levels will be developed by USACE.

Hydrographic surveys of proposed known existing reefs in the Neuse Estuary will be used for evaluation. A HSI will be computed for all identified sites. Existing reefs will be grouped by their potential to meet the habitat criteria under the existing condition and mapped accordingly. Another factor to be in included in the analysis is the relative depth of the reef site in the water column. Sites of sufficient height to provide optimum habitat should be so noted. However, some proposed reef sites have been harvested (excavated) in the past to depths where dissolved oxygen levels are too low to encourage persistent oyster growth. The minimum and optimum additional height needed to produce moderate or high ranking of these sites should be determined.

Water Quality Analysis Simulation Program (WASP)

The Water Quality Analysis Simulation Pro-gram—(WASP6), an enhancement of the original WASP (Di Toro et al., 1983; Connolly and Winfield, 1984; Ambrose, R.B. et al., 1988). This model helps users interpret and predict water quality responses to natural phenomena and man-made pollution for various pollution management decisions. WASP6 is a dynamic compartment-modeling program for aquatic systems, including both the water column and the underlying benthos. WASP allows the user to investigate 1, 2, and 3 dimensional systems, and a variety of pollutant types. The state variables for the given modules are given in the table below. The time-varying processes of advection, dispersion, point and diffuse mass loading and boundary exchange are represented in the model. WASP also can be linked with hydrodynamic and sediment transport models that can provide flows, depths velocities, temperature, salinity and sediment fluxes.



WASP has been used to examine eutrophication of Tampa Bay, FL; phosphorus loading to Lake Okeechobee, FL; eutrophication of the Neuse River Estuary, NC; eutrophication Coosa River and Reservoirs, AL; PCB pollution of the Great Lakes, eutrophication of the Potomac Estuary, kepone pollution of the James River Estuary, volatile organic pollution of the Delaware Estuary, and heavy metal pollution of the Deep River, North Carolina, mercury in the Savannah River, GA.

Eutrophication Module	Organic Chemical Module	Mercury Module
Dissolved Oxygen	Chemical 1	**Elemental Mercury**
CBOD (1)	Chemical 2	**Divalent Mercury**
CBOD (2)	Chemical 3	**Methyl Mercury**
CBOD (3)	Solids 1	**Sands**
Ammonia	Solids 2	**Fines**
Nitrate	Solids 3	
Organic Nitrogen		
Orthophosphate		
Organic Phosphorous		
Algae		
Benthic Algae		
Detritus		
Sediment Diagenesis		
Salinity		

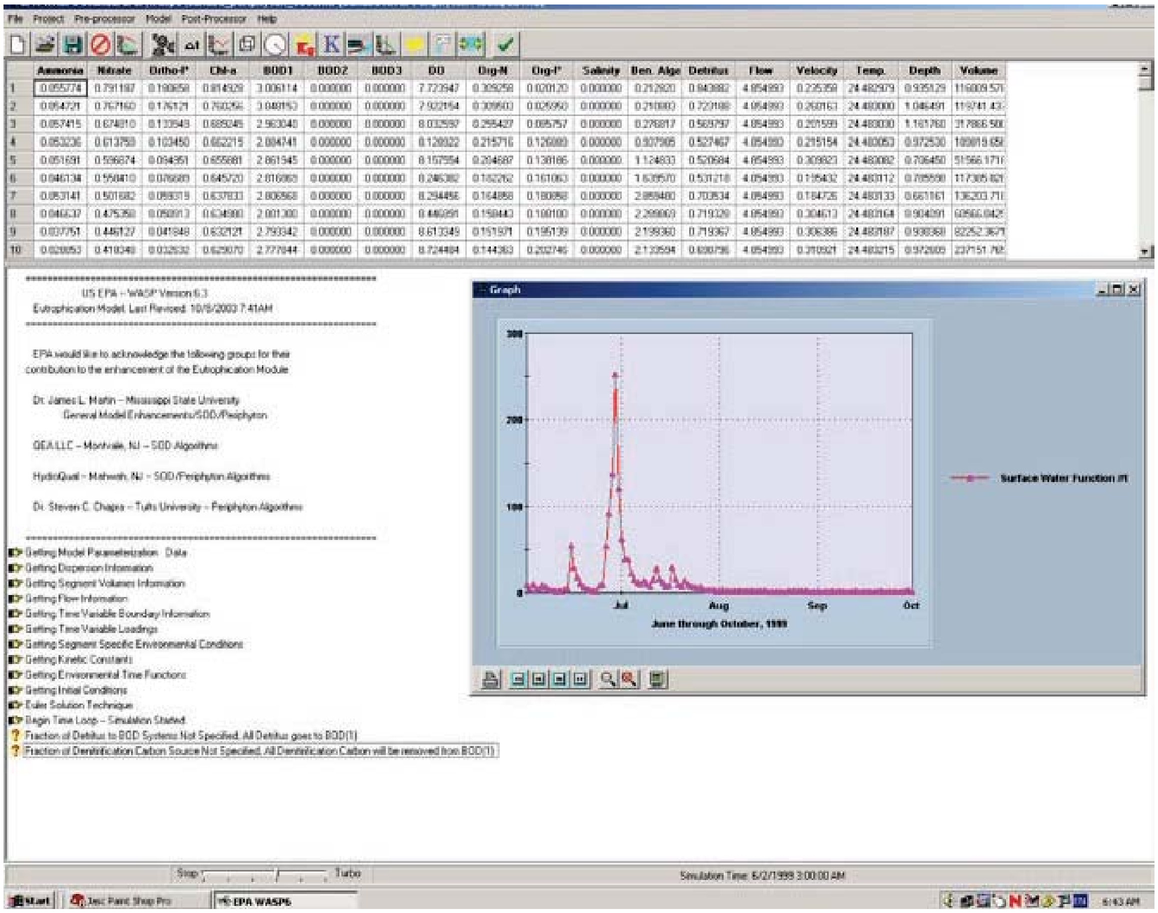
WASP Preprocessor

The data preprocessor allows for the rapid development of input datasets. The ability to bring data into the model is as simple as cut and paste or queried from a database. The preprocessor provides detailed descriptions of all model parameters and kinetic constants. When linking WASP with hydrodynamic models it is as simple as pointing to the hydrodynamic linkage file.

- Import time series from WRDB, Spreadsheet, Text Files
- Automatically import hydrodynamic model interface information
- Multi-session capable
- Run time diagnosis

Post Processor

The Post-Processor (MOVEM) provides an efficient method for reviewing model predictions and comparing them with field data for calibration. MOVEM has the ability to display results from all of the WASP models as well as others. MOVEM allows the modeler to displays the results in two graphical formats:



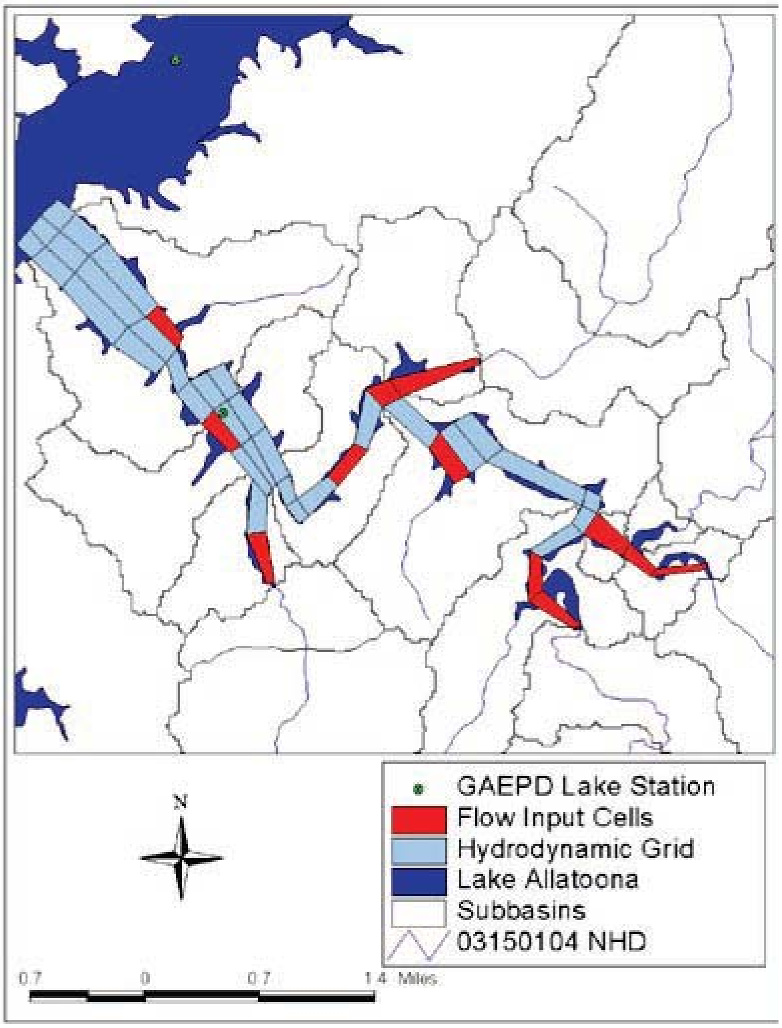
1) Spatial Grid—a two dimensional rendition of the model network is displayed in a window where the model network is color shaded based upon the predicted concentration.

2) x/y Plots—generates an x/y line plot of predicted and/or observed model results in a window.

There is no limit on the number of x/y plots, spatial grids or even model result files the user can utilize in a session. Separate windows are created for each spatial grid or x/y plot created by the user.

WASP Case Study for Little River Embayment, GA

WASP 6.1 was setup and calibrated for the Little River embayment on Lake Allatoona, Georgia to support the development of a nutrient TMDL for the State of Georgia. WASP was applied for three consecutive growing seasons during 2000, 2001, and 2002 to simulate phytoplankton growth due to excess nutrients from point and nonpoint sources. The Little River drains 214 square miles of primarily residential and agricultural land into Lake Allatoona, which is located on the Etowah River approximately 30 miles north of Atlanta, Georgia. The LSPC model was developed to simulate the watershed flows and nutrient constituents to input in the EFDC and WASP models. EFDC was used to simulate the hydrodynamics in the embayment and developed a hydrodynamic linkage file for WASP. The calibrated WASP model was used by the State to develop management strategies to ensure water quality standards are achieved.



Visit the Watershed & Water Quality Modeling Technical Support Center Website: http://www.epa.gov/athens/wwqtsc/index.html

Environmental Fluid Dynamics Code (EFDC)

The Environmental Fluid Dynamics Code (EFDC) is a state-of-the-art hydrodynamic model that can be used to simulate aquatic systems in one, two, and three dimensions. It has evolved over the past two decades to become one of the most widely used and technically defensible hydrodynamic models in the world. EFDC uses stretched or sigma vertical coordinates and Cartesian or curvilinear, orthogonal horizontal coordinates to represent the physical characteristics of a waterbody. It solves three-dimensional, vertically hydrostatic, free surface, turbulent averaged equations of motion for a variable-density fluid. Dynamically-coupled transport equations for turbulent kinetic energy, turbulent length scale, salinity and temperature are also solved. The EFDC model allows for drying and wetting in shallow areas by a mass conservation scheme. The physics of the EFDC model and many aspects of the computational scheme are equivalent to the widely used Blumberg-Mellor model and U. S. Army Corps of Engineers' Chesapeake Bay model. EFDC's role in the TMDL Toolbox will be to provide necessary hydrodynamic inputs to WASP, the advanced receiving water quality model.

EFDC Preprocessor

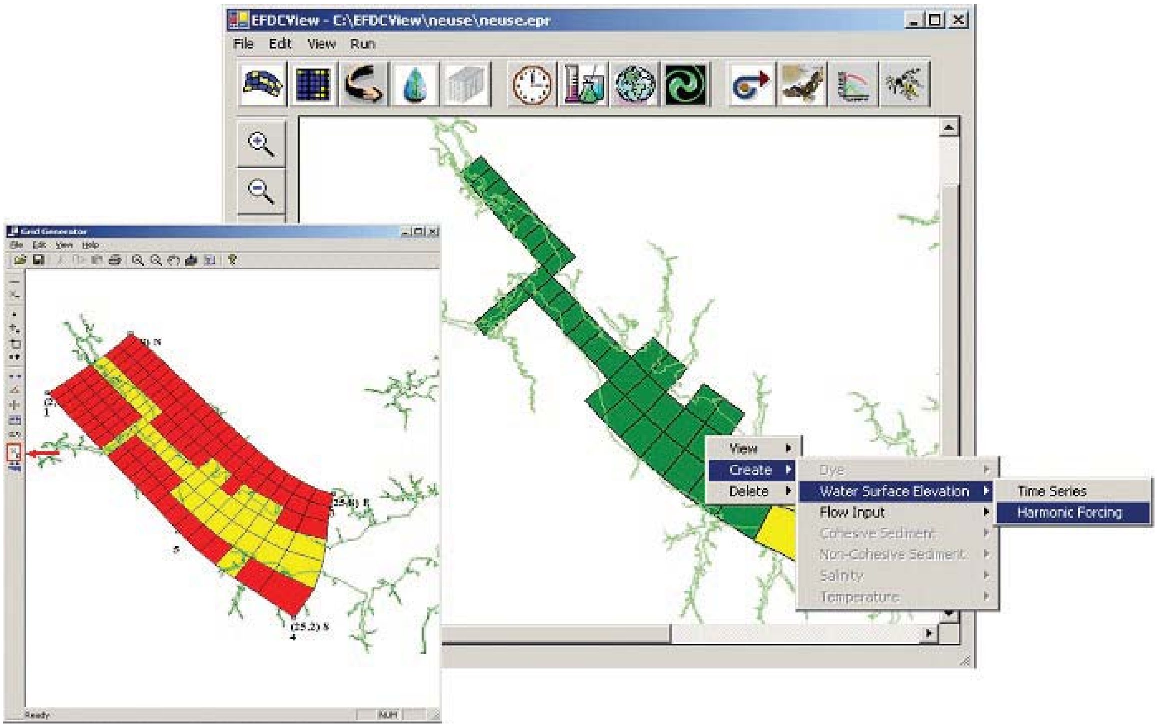
A preprocessor is being developed to facilitate the setup and application of EFDC for a wide range of applications. The preprocessor provides three significant tools to streamline the setup of an EFDC model: the VOGG Curvilinear Grid Generator, the EFDCView Model Interface, and the MOVEM Postprocessor. The VOGG Grid Generator and MOVEM postprocessor are stand-alone applications that may be ac cessed via the EFDCView environment. EFDCView enables the user to generate curvilinear-orthogonal grids, simulate aquatic systems in 1, 2, or 3-dimen-sions, link 2-D grids to 1-D grids, quickly and easily set and change critical modeling parameters, and make use of watershed loading model results and monitoring data for boundary conditions.

The VOGG Curvilinear Grid Generator enables a user to generate curvilinear-orthogonal grids that are required by EFDCView. It significantly decreases the repetitive effort typically required through manual grid generation methods. Grid generation is conducted interactively and intuitively through the interface and associated controls. Key features of the tool include:

- GIS interface
- Model domain designation through user control point designation
- Automatic insertion of grid boundary points based on control point designation
- Automatic curvilinear-orthogonal grid generation
- Model grid conversion to GIS shape file format
- Cell mapping between EFDC and WASP

Once a grid has been generated, it's necessary to set and calibrate pertinent modeling parameters. EFDCView simplifies the setup and application of EFDC through a shapefile format-based graphical interface and associated windows. It supports input of EFDC model run control and model parameter designation, and it links directly to boundary condition/source data, e.g. watershed model output and point source contributions. Key features of the tool include:

- Visual linkage to the model grid
- Visual linkage to point and nonpoint source inputs
- New model parameter addition and accommodation
- Direct linkage to WRDB for boundary condition designation/generation

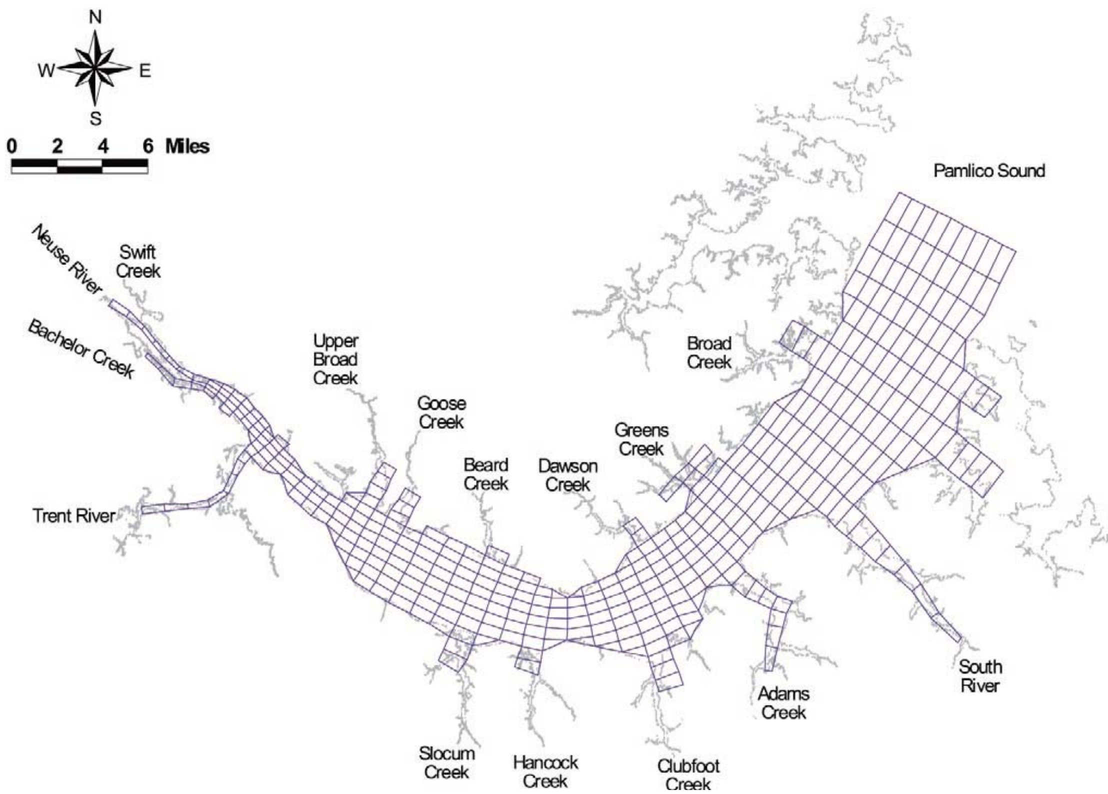


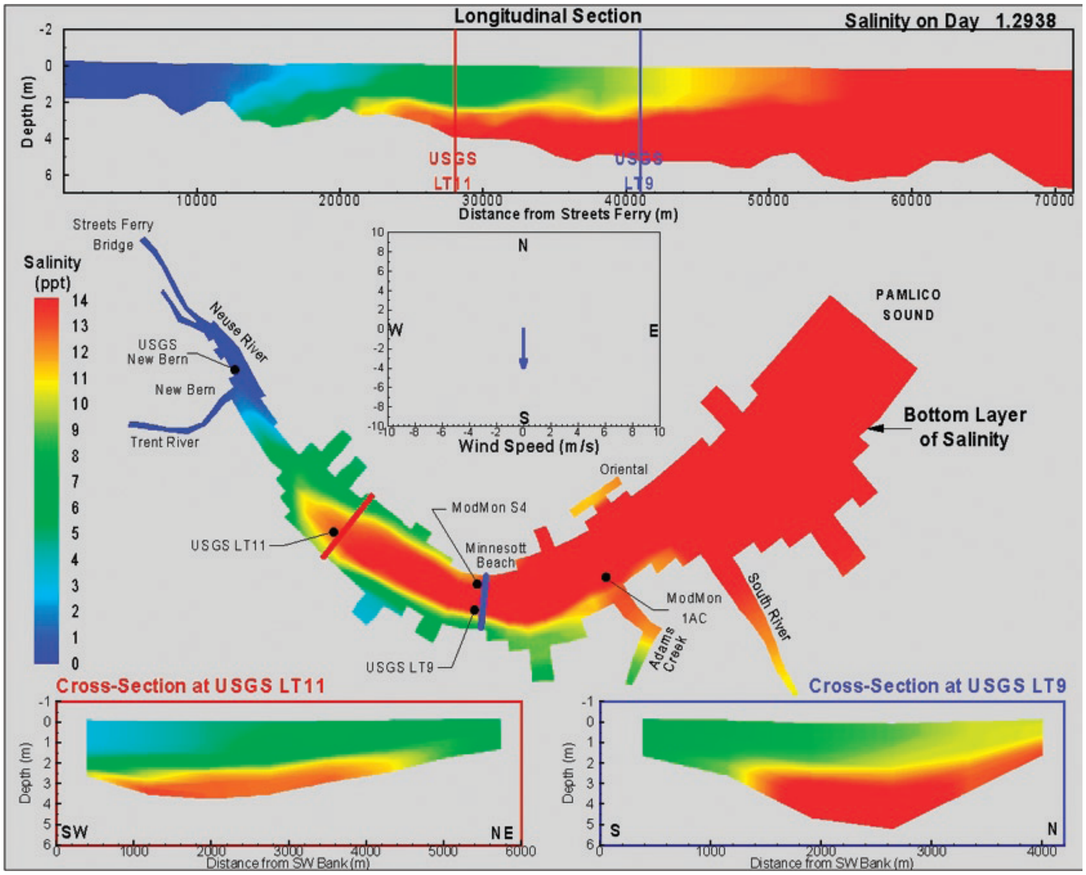
EFDC Application for the Neuse River Estuary, NC

The Neuse River Estuary was included on the State's 303(d) list for nutrients and was scheduled for TMDL development by the spring of 2001. The water quality targets within the system are based ultimately on chlorophyll-a concentrations. The target of 40 mg/L chlorophyll-a will be achieved within the Neuse Estuary through control of point and non-point discharges of nutrients, specifically nitrogen, within the Neuse River watershed and tributaries adjacent to the estuary.

Background

The Neuse River Estuary is located in eastern North Carolina at the confluence of the Neuse River and Pamlico Sound. The Neuse River is 179 miles long and it's watershed drains approximately 5,700 square miles from the coastal plain and piedmont provinces of the state. There have been significant concerns with the water quality in the estuary over the past decade, with a focus on nutrient loadings from surrounding land uses. The circulation and transport of materials within the Neuse Estuary are highly complex. Water surface elevation fluctuations within Pamlico Sound are on the order of 1 meter and provide a driving mechanism at the mouth of the estuary. These fluctuations are caused primarily by meteorological events creating "sloshing" within the Sound. Salinity intrusion to the system extends nearly 45 miles into the estuary and creates the characteristic residual estuarine circulation pattern of outflow on the surface and inflow at the bottom. Finally, local wind forcing creates conditions where the stratification within the estuary is overturned periodically altering the residual flow patterns.


N
W
E
S
0 2 4 6 Miles
Pamlico Sound
Neuse River
Swift Creek
Bachelor Creek
Upper Broad Creek
Goose Creek
Broad Creek
Greens Creek
Beard Creek
Dawson Creek
Trent River
Adams Creek
South River
Slocum Creek
Hancock Creek
Clubfoot Creek



Water quality within the Neuse Estuary is highly influenced by the complex circulation patterns. System characteristics include seasonal low dissolved oxygen near the bottom, areas of low flow and flushing causing algal blooms, overturning of low dissolved oxygen water where significant wind events follow periods of low energy, and backwater effects caused by set up of water surface elevation within Pamlico Sound.

TMDL Summary

In 1999 the State of North Carolina proposed to EPA Region 4 an initial target of 30 percent reduction in total nitrogen load from the Neuse River to the estuary. This work was Phase I of the Neuse Estuary TMDL. This initial reduction target was not determined through detailed model application and evaluation.
Under Phase II of the Neuse Estuary TMDL development, and in agreement with the State of North Carolina, EPA is utilizing the Environmental Fluid Dynamics Code (EFDC), a three-dimensional hydrodynamic model, linked with the EPA Water Quality Analysis and Simulation Program (WASP) to determine the level of nutrient reduction required for the Neuse Estuary to meet the designated uses. The Hydrological Simulation Program FORTRAN (HSPF) and Nonpoint Source Model (NSPM) were utilized in conjunction with US EPA Region 4's Watershed Characterization System to provide loads directly to the estuary model. The model was applied over a 3-year period, examining the chlorophyll-a levels in the system, both longitudinally distributed as well as lateral variations. In addition to examining the effects of nutrients on chlorophyll-a concentrations, EPA will be able to determine the frequency of anoxic conditions in the

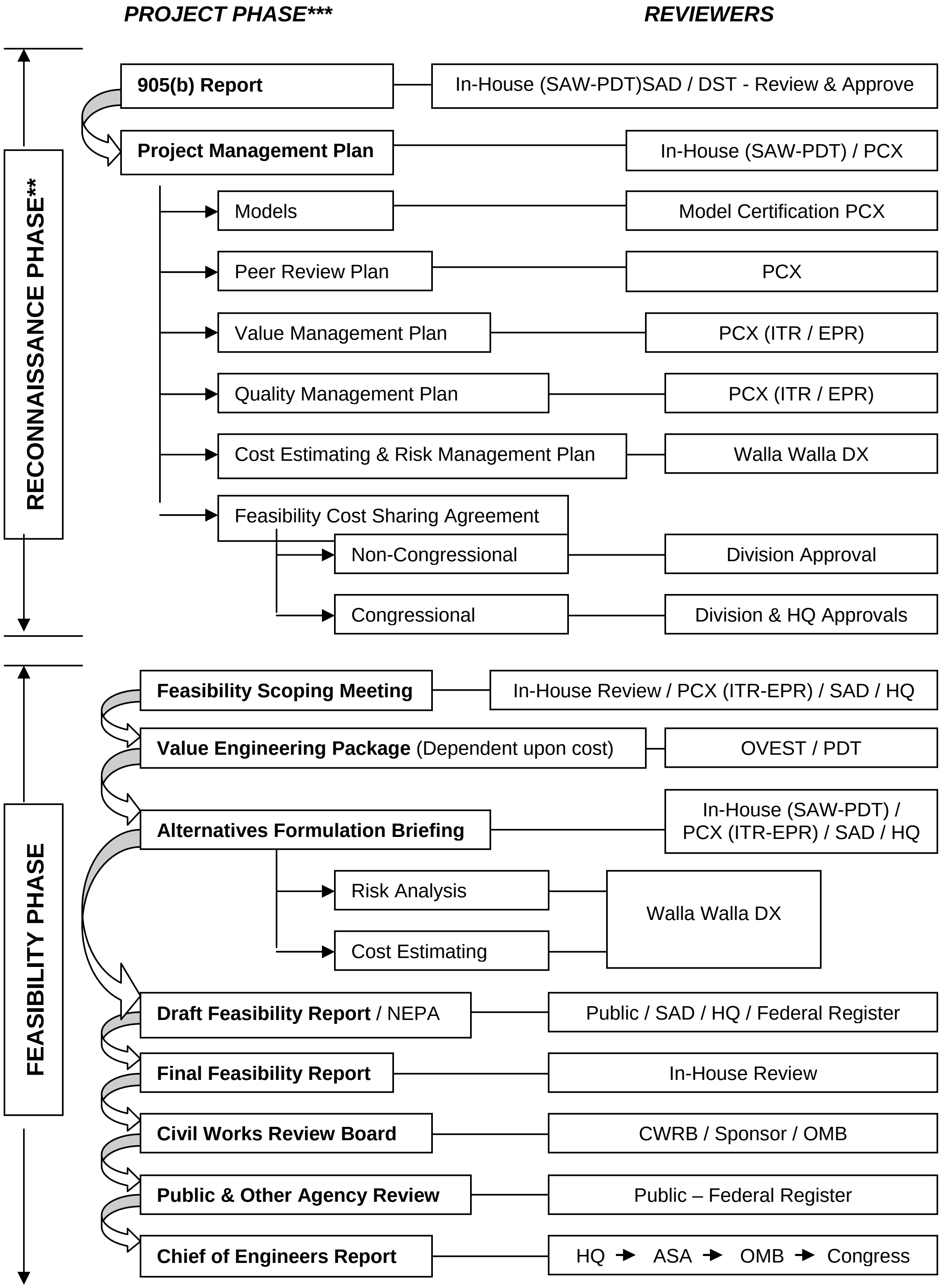
lower waters of the estuary due to nutrient enrichment, and the benefits gained (relative to dissolved oxygen) through nutrient reduction.

Visit the Watershed & Water Quality Modeling Technical Support Center Website
http://www.epa.gov/athens/wwqtsc/index.html

ATTACHMENT 3

PEER REVIEW PLAN

PEER REVIEW PLAN*



***** Reference External Peer Review Decision Checklist in Section b., questions 1 - 5: if any changes occur in checklisted items, the vertical team will determine if External Peer Review (EPR) will be required. A decision regarding EPR is requested in writing from SAD and HQ Regional Integration Team Leader (RIT).

**A Scoping Letter during the Reconnaissance Phase provides the Public the opportunity to share any known concerns.
***The Project Delivery Team (PDT) includes the non-Federal Sponsor, stakeholders, and resource agencies.

ATTACHMENT 4

ITR APPROVAL REQUEST

Establishment of ITR responsibility has been an evolving process. Skilled and experienced personnel who have not been associated with the development of the Neuse River Basin Feasibility Study products have been previously requested by Wilmington District Plan Formulation and Economics. USACE, Baltimore District was requested to perform ITR for the Neuse River Feasibility Scoping Meeting Package. Due to this being a very preliminary phase in the Feasibility Study and resources already expended on requesting ITR Team members, it is requested that these ITR Team Members be evaluated and approved to perform this upcoming ITR. Please note that several projects completed by the Baltimore District require very similar fields of expertise as shared by Wilmington District Team Members who have developed the Feasibility Scoping Meeting Package.

Plan Formulation

Name: Jeff Trulick
Grade and position title: GS-12, Biologist
Organization: Baltimore District, Planning Division (CENAB-PL-P)
Education: B.S. in Biology, The Pennsylvania State University, 1990
Years of experience: 15
Major achievements and projects: Study of acidic precipitation on amphibian breeding success, several years as Regulatory project manager in Baltimore District, several years as project manager/biologist in Baltimore District Planning Division. Significant experience is in NEPA compliance, Essential Fish Habitat assessments, aquatic resource ID and conservation, wetland delineation, wetland functional assessment, wetland mitigation and construction, stream habitat assessment, evaluation, restoration, acid mine drainage and watershed planning issues. Significant experience in GI study management, plan formulation and Civil Works policy compliance and interpretation. Experience preparing project briefs for three project Civil Works Review Boards (Bloomsburg, Poplar Island Expansion and Site 1).

As a project manager on a variety of Civil Works projects have prepared schedules, scopes, budgets and managed project teams in execution of ecosystem restoration and flood damaged reduction investigations. Also routinely engaged non-Federal sponsors, contractors and stakeholders during this execution. ½ my time is currently (c. April 2007) funded as a project manager on South Florida Restoration projects for Jacksonville District.

As a study manager/plan formulation lead, prepared study scopes, schedules, budgets, array of alternatives, report production, quality control and managed study teams during execution of these project phases. I have managed several tasks related to ecosystem restoration planning, formulation and economics.

As a project biologist and NEPA practitioner, prepared many environmental assessments for many different types of projects. Involved with scoping and preparing Environmental Impact Statements. Also responsible for quality control reviews of various project reports, plan formulation and environmental documents for several different types of projects.

Other awards and relevant accomplishments:
Several on the spot awards for my technical work in Baltimore's Operations and Planning Divisions.
Developmental detail to intergovernmental liaison officer position working in the District's Executive office (2003).
Commander's Coin-SAJ (2006)
Professional Memberships:
Virginia Association of Wetland Professionals
New York State Wetland Forum
Society of Wetland Scientists (Certified)
Training:
Aerial Photo Interpretation, May 1994
Intermediate Plant Identification, June 1994
Wetland Delineation, September 1994
Cultural Resources Training, Dec 1994
Procedures for Assessing Wetland Functions, Nov 1995
Applied Fluvial Morphology, Mar 1996
Stream Classification and Application, May1996
ALI-ABA Wetlands Law and Litigation (field instructor and attendee), May 1996
Watersheds '96 Conference, May 1996
Conflict Resolution and Confrontation Skills, June 1996
One Minute Manager, 1996
EPA Region 3 Wetlands Regulatory Conference (multiple)
EPA Region 3 Shallow Water Conference Mar 1998
Mid-Atlantic Integrated Assessment Conference-1998
Civil Works Orientation Course-2001
Plan Formulation-Core Curriculum-2003
PMI Project Manager Certification-2004

Environmental

Christopher Spaur

EDUCATION

- M.S. in Marine Science (Geology Minor). North Carolina State University, College of Physical and Mathematical Sciences, 1993.
- B.S. in Natural Resource Management. Rutgers University, Cook College, 1985.

USACE POSITION

Ecologist (GS-12), NAB, Planning Division. January 1994 to Present (13 1/3 years). Environmental team member on Corps' project planning teams during reconnaissance, feasibility, and plans/specification study phases. Make substantial contributions to plan formulation to optimize ecosystem benefits on restoration studies and ensure appropriate environmental mitigation measures are incorporated on traditional studies through office and occasional fieldwork. Office work includes literature review and compilation of environmental information, study report authorship and preparation, and participation in internal and interagency meetings. Coordinate extensively with resource agencies. Occasional fieldwork performed includes wetland determinations, stream rapid habitat assessments, stream stage and discharge measurements, submerged aquatic vegetation bed surveys, and herbaceous and woody plant surveys. Completed 9 month temporary detail in Operations Division, Regulatory Branch. Processed permit applications and was member of internal SAV/Dredging workgroup.

Primary author on one Supplemental EIS (advanced draft, currently at NAD), two completed integrated feasibility report/EAs, seven completed stand-alone EAs, and five Preliminary Restoration Plans (Section 905b Reports). Contributing author to three integrated EIS/feasibility reports, two integrated EA/feasibility reports, and five reconnaissance reports. Have prepared numerous Clean Water Act 404 (b)(1) Analyses, several Essential Fish Habitat Impact Analyses, and one Endangered Species Act Biological Assessment. Reviewer on environmental technical and NEPA compliance matters for NAB documents (EISs, EAs, feasibility reports, reconnaissance reports). Interagency reviewer for several Minerals Management Service Continental Shelf reports, and one U.S. Geological Survey report (sediment processes of Chesapeake Bay). Have given presentations at numerous conferences and workshops on Corps' projects and on focused natural resource management issues. Presently serve on Chesapeake Bay Program Sediment Workgroup and Maryland Coastal Bays Scientific and Technical Advisory Committee.

EXTERNAL PUBLICATIONS

Spaur, C.C., and S.W. Snyder. 1999. Coastal wetlands evolution at the leading edge of the marine transgression, Jarrett Bay, North Carolina. Journal of the Elisha Mitchell Scientific Society, 115(1): 20-46.

Spaur, C.C., B.E. Nichols, T.E. Hughes, and P.M. Noy. 2001. Wetland losses in Maryland's coastal bays watershed since the beginning of the twentieth century and their implications for wetlands restoration, p. 291-302. In: G.D. Therres (ed.), Conservation of Biological Diversity. Conference Proceedings. Maryland Dept. of Natural Resources, Annapolis. (http://www.vims.edu/GreyLit/MDNR/Conference1998.pdf)

Spaur, C.C., and J.B. Stribling. 2007 (in press). When Should Degraded Stream Geomorphic Conditions be Considered a Restoration Priority to Improve Conditions for Aquatic Life? Chapter contribution to NRCS Stream Restoration Design Guide (National Engineering Handbook 654 [Draft]).

Cost Estimating

Luan Ngo currently serves as a Cost Engineer (GS-12) for the Estimating and Specifications Section, Baltimore District Corps of Engineers. He is a 1999 Graduate of Tulane University with a B.S. in Chemical Engineering. He has 5 years of Cost Engineering for planning and design/construction phases for broad range of civil/military/HTRW projects (Wyoming Valley WB2c, Wyoming Valley Relief Well Seepage Repairs, Paint Branch, Belle Haven and Huntington Flood Damage Reduction FS, Waterbury Dam Gate Repair FS, Newton Creek, PL84-99, JRL Spillway; Section 219 Halls Station, Carlisle Barracks MSF, LTL Facility, Sample Receipt Facility, Automotive Test Evaluation Facility, APG Barracks Renovations, Ft. Detrick Steam Plant, Library of Congress Module 3&4, Spring Valley CTCs, CON/HTRW Missile Silo Closures, Ft. Miles MMRP FPRI); technical/price analysis and assistance for 8A and RFP contracts. Certified as Cost Consultant through DoD Tri-Service Cost Engineering Certification Board. Responsibilities include estimate preparations for in-house designs and modifications, and A/E and ITR estimate reviews via Dr. Checks system. Other duties include 1391/3086 estimate reviews and preparations via PC-Cost and PAX system. Proficient in estimating programs such as MII, MCACES for Windows, Costworks, PACES, PC-Cost, and RACER.

<u>Hydrology & Hydraulics</u>

Karen Nook is a senior hydraulic engineer (GS-12) with the Water Resources Section of the U.S. Army Corps of Engineers, Baltimore District. Ms. Nook has over 18 years of experience in water resources planning and engineering for the Corps of Engineers and the private sector. She has worked on planning and design of projects for shoreline erosion protection, harbor protection, dredged material placement, ecosystem restoration, and flood damage reduction. Ms. Nook has experience in wave analysis and hydrodynamic modeling for coastal and estuarine projects, as well as hydrologic and hydraulic modeling for flood damage reduction projects and FEMA flood insurance studies. She currently serves as the lead hydraulic engineer on the Section 205 Lycoming Creek Flood Damage Reduction Study and on several large shoreline protection and estuarine restoration projects in the Chesapeake Bay including the Mid-Chesapeake Bay Island Ecosystem Restoration Feasibility Study, the Chesapeake Bay Shoreline Erosion Feasibility Study, and the Blackwater Wildlife Refuge Ecosystem Restoration Study. Ms. Nook graduated with a B.S. in Civil Engineering from the University of Delaware in 1988 and a Masters Degree in Environmental Engineering and Science from Johns Hopkins University in 2006. Ms. Nook is a registered professional engineer in the State of Maryland.

<u>Real Estate</u>

Adam L. Oetreich (GS-12)
North Atlantic Division
Baltimore District
Realty Specialist
CENAB-RE-C
Baltimore, Maryland
(410) 962-2209
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Adam serves as a Realty Specialist in the Baltimore District Civil Projects Support Branch. He has been in this position for approximately 10 years, working primarily in the areas of acquisition, P.L. 91-646 relocations and management of real estate for Corps operations and maintenance projects, including navigation and flood control. He has also been the real estate Project Delivery Team member on various flood damage reduction and ecosystem restoration feasibility studies and construction projects, as well as dam safety assessment studies. These include cost-shared projects requiring interaction with diverse shareholders to complete the study or project while complying with applicable laws and regulations.

Prior to this, Adam worked in the Homeowners Assistance Program for 4 years, as both a Realty Specialist and Program Analyst for BRAC actions in the northeast. Adam also served as an Intelligence Analyst in the US Army, including a 2-year tour in West Germany (FRG), 1983-1985. He has a B.S., College of Business, Pennsylvania State University, 1990.